Information Bulletin | Applied Mathematics 30

2008–2009 Diploma Examinations Program

Alberta Education

Contents

Please note that if you cannot access one of the direct website links referred to in this document, you can find diploma examination-related materials on the Alberta Education website at www.education.alberta.ca.

At the home page, click on the link *Provincial Testing* under *For Administrators*. Next click on *Diploma Examinations* and then one of the specific links listed under the *Diploma Examinations* heading.

Introduction

The purpose of this bulletin is to provide students and teachers of Applied Mathematics 30 with information about the diploma examinations scheduled in the 2008–2009 school year. This bulletin should be used in conjunction with the current Applied Mathematics Program of Studies to ensure that the curriculum and standards are addressed.

This bulletin includes descriptions of the Applied Mathematics 30 Diploma Examinations that will be administered in January, June, and August of 2009; descriptions of the *acceptable standard* and the *standard of excellence*; and subject-specific information. The mark awarded to a student on the Applied Mathematics 30 Diploma Examinations in the 2008–2009 school year will account for 50% of the student's final blended mark, and the school-awarded mark will account for the remaining 50%.

Teachers are encouraged to share the contents of this bulletin with students.

For further information regarding program implementation, refer to the Alberta Education website at www.education.alberta.ca.

Course Objectives

The Applied Mathematics 30 course is made up of outcomes, as specified in the Program of Studies, and emphasizes the application and relevance of mathematics in daily life. In Applied Mathematics, numerical and geometric methods are used to solve problems. Algebraic constructs are taught as needed during classroom investigations or data analysis. Tools such as graphing calculators and spreadsheet applications are commonly used to solve problems.

Students are expected to communicate solutions to problems clearly and effectively when solving both routine and non-routine problems. Technology is to be used for exploration, modelling, and problem solving. Students are also expected to apply mathematical concepts and procedures to meaningful life problems.

Teacher Involvement in the Diploma Examination Process

High-quality diploma examinations are the product of close collaboration between classroom teachers and Alberta Education. Classroom teachers from across Alberta are involved in many aspects of diploma examination development, including the development of raw items; the building, reviewing, administering, and marking of field tests; the reviewing of diploma examination drafts; and the marking of diploma examinations.

Alberta Education values the involvement of the teachers and often asks school jurisdictions for the names of teachers who are interested in being involved. Teachers who are interested in developing raw items or building and/or reviewing field tests are encouraged to ask their principals to submit their names, through proper channels, to Learner Assessment. The list of teachers interested in these aspects of the development process remains open all year long, and teachers are welcome to have their names submitted at any time.

Other opportunities to be involved, such as field testing and marking, have specific closing dates. General dates to be aware of include:

September 2008	Registration for unit field tests to be administered throughout the semester and for year end field tests to be administered in December 2008 or January 2009.
October 2008	Request for marker nominations for diploma examinations to be administered in January 2009.
February 2009	Registration for unit field tests to be administered throughout the semester and for year end field tests to be administered in May or June 2009.
March 2009	Request for marker nominations for diploma examinations to be administered in June and August 2009.

Performance Standards

Curriculum Standards

Provincial curriculum standards help to communicate how well students need to perform in order to be judged as having achieved the learnings specified for Applied Mathematics 30. The specific statements of standards are written primarily to apprise Applied Mathematics 30 teachers of the extent to which students must both know the Applied Mathematics 30 content and demonstrate the required skills in order to pass the examination.

Acceptable Standard

Students who attain the *acceptable standard* but not the *standard of excellence* in Applied Mathematics 30 will receive a final course mark between and including 50% and 79%. Typically, these students have gained new skills and knowledge in mathematics, and they can apply mathematical concepts and procedures to find a solution to routine problems. They have demonstrated mathematical skills and knowledge in the six topics of the Applied Mathematics 30 curriculum and exhibit an ability to apply a broad range of problem-solving skills to these content strands.

Standard of Excellence

Students who attain the *standard of excellence* will receive a final course mark of 80% or higher. Such students have demonstrated their ability and interest in mathematics, and have confidence in their mathematical skills. These students can choose the most efficient method for solving problems. They can also find more than one solution and can solve non-routine problems.

Examples of Questions

This bulletin contains examples of selected written-response questions, sample student responses, and scoring rationales as they relate to the general scoring guide. For examples of machine-scored questions and other written-response questions, please refer to the *Applied Mathematics 30 Archived Bulletin Information*.

Term Project

Alberta Education will produce three projects (large-scale mathematical problems) per year for Applied Mathematics 30. These projects are designed to be completed in three to five hours of student time. Use of these projects is optional, and teachers may choose to use them as part of their assessment. A sample solution and scoring rubric will be provided for each project. For the 2008–2009 school year, Applied Mathematics 30 projects will be made available according to the chart below, and one of the written-response questions, worth 10% on the indicated diploma examination, will be related to each project.

Diploma Exam	Project Available
January 2009	Distributed to schools in mid-August 2008
June 2009	Distributed to schools in mid-January 2009
August 2009	*Apiculture—The Beekeeping Industry* posted on the Alberta Education website

The related written-response question on each diploma examination may not have the same scenario as the project; however, many of the mathematical skills required to complete the project will be similar to those required in the written-response question. Students who do not complete the project but who complete the course will have the knowledge to answer the written-response question; however, students who complete the project will have experience with the related mathematical skills in another context.

Examination Specifications and Design

Each Applied Mathematics 30 Diploma Examination is designed to reflect the core content outlined in the *Applied Mathematics 30 Program of Studies*. The examination is limited to those expectations that can be measured by a paper-and-pencil test. Therefore, the percentage weightings shown below will not necessarily match the percentage of class time devoted to each unit. Applied Mathematics 30 Diploma Examinations will be separated into Part A (written-response items) and Part B (machine-scorable items), and the two parts will be administered at different times. Part A will be one hour in length, and Part B will be two hours, with an additional half-hour for each part if needed.

The content for the Applied Mathematics 30 Diploma Examinations in the 2008–2009 school year is emphasized as follows.

Part	*Question Format*	*Number of Questions*	*Percentage Emphasis*
A	Written Response	3	35
B	Multiple Choice	33	55
	Numerical Response	6	10

Procedural, conceptual, and problem-solving cognitive levels are addressed throughout the examination. The approximate emphasis of each cognitive level is given below.

Multiple Choice, Numerical Response, and Written Response	***Percentage Emphasis***
Procedures	35
Concepts	30
Problem Solving	35

Machine-Scored Content	***Percentage Emphasis***
Matrices and Pathways	17
Finance and Spreadsheets	17
Statistics and Probability	17
Vectors	18
Cyclic, Recursive, and Fractal Patterns	18
Design	13

Written-Response Questions

The written-response questions focus on students' understanding of the process of solving a problem and encourage students to take risks to arrive at a solution. Students will be rewarded for selecting a problem-solving strategy and for carrying through with the strategy to find a solution. Written-response questions assess the degree to which students can draw on their mathematical experiences to solve problems and explain mathematical concepts. Therefore, the written-response questions will not necessarily fall into a particular unit of study but may cover more than one unit or may require students to make connections between mathematical concepts. Of the seven mathematical processes, the written-response questions will address communication, problem solving, connections, reasoning, and technology. (See pages 10–11 for an explanation of these processes.)

To achieve the *standard of excellence*, students must be able to select a strategy, carry it through, and solve the problem correctly. The written-response questions also focus on students' understanding of mathematical concepts and allow for flexibility in evaluating students' communication and problem-solving abilities in mathematics.

Written-response questions ask students to solve, explain, justify, or prove their solution. Students are required to know the definitions of directing words such as **determine**, **evaluate**, **explain**, **graphically**, **justify**, **show how**, and **sketch**. (See pages 23-24.)

In scoring the written-response questions, markers will evaluate how well students

- understand the problem or the mathematical concept
- correctly apply mathematical knowledge and skills
- use problem-solving strategies, and explain their solutions and procedures
- communicate their solutions and mathematical ideas

One of the two 10% questions will be related to the term project provided to all schools by Alberta Education. The 15% question will focus on the mathematical processes of reasoning and connections.

Above all, students should be encouraged to try to solve all problems. Even an attempt at a solution could be worth some marks. The three written-response questions are each scored with a five-mark scoring rubric. Students should note that their solutions to all written-response questions should include appropriate use of units and appropriate rounding.

Machine-Scored Questions

Information required to answer **multiple-choice** and/or **numerical-response questions** is often located in a box preceding the question. The number of questions that require the use of the information given in the box will be clearly stated above the box: e.g., "*Use the following information to answer the next two questions.*"

For **multiple-choice questions**, students are to choose the correct or best possible answer from the four alternatives.

For some **numerical-response questions**, students are to calculate a numerical answer and record their answer in a separate area of the answer sheet. When the answer to be recorded cannot be a decimal value, students are asked to determine a whole number value: e.g., the number of people is _____; the degree of this polynomial is _____. If the answer can be a decimal value, then students are asked to record their answer to the nearest tenth or nearest hundredth, as specified in the question. Students should retain all decimals throughout the question, and rounding should occur only in the final answer.

Other numerical-response questions require students to record their understanding of a conceptual idea. The following is an example of such a question.

Use the following information to answer the next question.

$$2\begin{bmatrix} 1 & 0.5 \\ 1.5 & 4 \end{bmatrix} = \begin{bmatrix} a & b \\ c & 8 \end{bmatrix}$$

Numerical Response

6. In the equation above, the value of

a is _____ (Record in the **first** column)
b is _____ (Record in the **second** column)
c is _____ (Record in the **third** column)

(Record your answer in the numerical-response section on the answer sheet.)

Answer: 213

Record 213 on the answer sheet →

Examination Security

All Applied Mathematics 30 Diploma Examinations will be held secure until released to the public by the Minister. However, for the January and June 2009 examinations, teachers will be allowed access to a *Teacher Perusal Copy* for review purposes one hour after the respective examination has started. Representative portions of previous diploma examinations will be released, along with an *Assessment Highlights Document*, early in the autumn of 2009.

Maintaining Consistent Standards Over Time on Diploma Examinations

A goal of Alberta Education is to make examinations directly comparable from session to session, thereby enhancing fairness to students across administrations. Diploma examinations in all courses, except Science 30, French Language Arts 30, and Français 30, are now equated.

To achieve this goal, a number of questions, called anchor items, remain the same from one examination to the next. Anchor items are used to find out if the student population writing in one administration differs in achievement from the student population writing in another administration. Anchor items are also used to find out if the unique items (questions that are different on each examination) differ in difficulty from the unique items on the baseline examination (the first examination to use anchor items). A statistical process, called equating, adjusts for the differences in examination form difficulty. Examination marks may be adjusted slightly upward or downward, depending upon the difficulty of the examination written relative to the baseline examination. The resulting equated examination scores have the same meaning regardless of when and to whom the examination was administered. Equated diploma examination marks will be reported to students.

Because of the security required to enable fair and appropriate assessment of student achievement over time, both Parts A and B of some diploma examinations may have to be fully secured on occasion and will not be released at the time of writing. Please check the *General Information Bulletin* (www.education.alberta.ca, then follow the pathway: Teachers > (Additional Programs and Services) Diploma Exams > Diploma General Information Bulletin) or the information bulletins for each diploma subject you teach to determine which, if any, examinations are fully secured. For more information about equating, please refer to the Alberta Education website at www.education.alberta.ca, then follow the pathway: Teachers > (Additional Programs and Services) Diploma Exams > Initiative to Maintain Consistent Standards on Diploma Examinations.

Assessment of the Mathematical Processes

Open-ended questions provide a way in which to assess mathematics as a common human activity. They allow students to communicate a response by asking them to explain their reasoning, explain their solution, describe mathematical situations, write directions, create new problems, create new strategies, generalize a mathematical situation, and formulate hypotheses.

The written-response questions provide an opportunity to evaluate several mathematical processes as outlined in the *Program of Studies*: communication, problem solving, connections, reasoning, technology, estimation and mental mathematics, and visualization. Technology may be incorporated into all three written-response questions.

Communication (C)

"Students need to communicate mathematical ideas clearly and effectively, orally and in writing" (*Mathematics Applied and Pure Programs,* page 6). Students are expected to provide clear, concise answers to the written-response questions. Students should clearly communicate all pertinent steps used to arrive at a solution. Students should use correct mathematical notation and conventions, and may use graphs or diagrams in their solutions.

In communicating answers, students must be aware of the degree of accuracy required as well as the appropriate units involved.

Problem Solving (PS)

"Problem solving is the focus of mathematics at all grade levels. The development of each student's ability to solve problems is essential. Students develop a true understanding of mathematical concepts and procedures when they solve problems in meaningful contexts" (*Mathematics Applied and Pure Programs,* page 8). Approximately 36% of the machine-scored questions as well as portions of the written-response questions will be related to a problem-solving context. Students are expected to be able to select an appropriate problem-solving strategy to find the solution to a given problem or to model meaningful problem situations.

Students should not expect questions on a particular concept to be asked in the same manner every time. They must be able to adapt to changes in the format, which will help to improve their problem-solving skills.

Connections (CN)

"When mathematical ideas are connected to each other through concrete, pictorial and symbolic representations, students begin to view mathematics as an integrated whole" (*Mathematics Applied and Pure Programs,* page 7). Students need numerous and varied experiences to appreciate the usefulness of mathematics. They must explore connections between different areas of mathematics, and

between mathematics and other disciplines. The "connections process" also includes relating mathematics to their own daily experiences.

The connections process is often linked with problem solving and reasoning, as it is an application of these other processes.

Reasoning (R)

"Students need to develop confidence in their ability to reason and to justify their thinking within and outside of mathematics. The power of reasoning helps students to make sense of mathematics, to be logical in their thinking, and to convince others.

"Inductive reasoning helps students explore and make conjectures from activities that allow generalizations from a pattern of observations.

"Deductive reasoning helps students test conjectures and build arguments that serve to validate thinking. Deductive reasoning builds a structured body of knowledge." (*Mathematics Applied and Pure Programs,* page 9)

Reasoning allows students to interpret mathematics and aids in the choice of appropriate problem-solving strategies. Students may be asked to demonstrate logical reasoning when judging the validity of arguments, testing conjectures, and constructing valid arguments.

Technology (T)

"Electronic technologies—calculators and computers—are essential tools for teaching, learning, and doing mathematics. They furnish visual images of mathematical ideas, they facilitate organizing and analyzing data, and they compute efficiently and accurately. They can support investigation by students in every area of mathematics, including geometry, statistics, algebra, measurement, and number. When technological tools are available, students can focus on decision making, reflection, reasoning, and problem solving.... Technology should not be used as a replacement for basic understandings and intuitions; rather, it can and should be used to foster those understandings and intuitions." *(Principles and Standards for School Mathematics, NCTM 2000,* pages 24 to 25*)*

Explanation of Cognitive Levels

Procedural, conceptual, and problem-solving cognitive levels are addressed throughout the examination. The emphasis of each cognitive level will be approximately equal.

Procedures

The assessment of students' knowledge of mathematical procedures should involve recognition, defence, execution, and verification of appropriate procedures and the steps contained within them. Students must appreciate that procedures are created or generated to meet specific needs in an efficient manner and thus can be modified or extended to fit new situations. The use of technology can allow for conceptual understanding prior to specific skill development. Assessment of students' procedural knowledge will not be limited to an evaluation of their proficiency in performing procedures, but will be extended to reflect the skills presented above.

Certain types of procedural execution cannot be tested on diploma examinations because of restrictions in technology. This procedural execution is, however, an integral part of the *Program of Studies* and should be tested in the classroom.

Concepts

An understanding of mathematical concepts goes beyond a mere recall of definitions and recognition of common examples. Assessment of students' knowledge and understanding of mathematical concepts should provide evidence that they can compare, contrast, label, verbalize and define concepts; identify and generate examples and non-examples as well as properties of a given concept; and recognize the various meanings and interpretations of concepts. Students who have developed a conceptual understanding of mathematics can also use models, symbols, and diagrams to represent concepts. Appropriate assessment will also provide evidence of the extent to which students have integrated their knowledge of various concepts.

Problem Solving

Appropriate assessment of problem-solving skills is achieved by allowing students to adapt and extend the mathematics they know and by encouraging the use of strategies to solve unique and unfamiliar problems. Assessment of problem solving involves measuring the extent to which students use these strategies and knowledge, and their ability to verify and interpret results. Students develop an ability to solve problems over time as a result of their experience with relevant situations that present opportunities to solve various types of problems.

Evidence of problem-solving skills is often linked to clarity of communication. Students demonstrating strong problem-solving skills should be able to clearly explain the process they have chosen using clear language and appropriate mathematical notation and conventions.

General Scoring Guide

Student responses to written-response questions will be scored against specific question-scoring rubrics based on the *General Scoring Guide*. Credit will be given to students who appropriately demonstrate unusual insight in addressing the question.

A "five" need not be a perfect paper!

This scoring guide reflects a mark based on four dimensions:

- mathematical understanding
- application of processes
- clarity of communication
- use of technology

GENERAL SCORING GUIDE	
1 mark	In the response, the student • applies some relevant mathematical knowledge to explore the initial stages of the problem; however, the response reflects a misunderstanding of the problem • uses a relevant strategy, mathematical process, or problem-solving technique to explore the initial stages of the problem • communicates very little relevant information and lacks clarity • uses technology inappropriately or the use of technology is not evident
2 marks	In the response, the student • applies some relevant mathematical knowledge to find partial solutions to the problem; however, the response reflects a minimal understanding of the problem • uses relevant strategies, mathematical processes, or problem-solving techniques to find a partial solution to the problem • communicates strategies in a manner that lacks clarity or is incomplete • uses technology where appropriate; however, errors are evident
3 marks	In the response, the student • applies mathematical knowledge to find partial solutions to the problem and reflects a basic understanding of the problem • uses appropriate strategies, mathematical processes, and problem-solving techniques to find **partial** solutions to the problem • communicates strategies and solutions in an organized manner; however, errors, inconsistencies, and omissions affect clarity • uses technology appropriately; however, there are inconsistencies in their application
4 marks	In the response, the student • applies appropriate mathematical knowledge to find a complete solution to the problem and reflects a good understanding of the problem • uses appropriate strategies, mathematical processes, and problem-solving techniques to find a **complete** solution to the problem; however, the solution contains an error that hinders understanding of the response • communicates strategies and solutions in an organized manner; however, errors or omissions may affect clarity • uses technology appropriately
5 marks	In the response, the student • applies appropriate mathematical knowledge to find a complete and correct solution to the problem, and reflects an excellent understanding of the problem • uses appropriate strategies, mathematical processes, and problem-solving techniques to find a complete, correct solution; the solution may have a minor error, but it does not hinder the understanding of the response • communicates strategies and solutions in a clear, complete, and organized manner that reflects a thorough understanding of the problem • uses technology effectively

Scoring Written-Response Questions

This section provides examples of selected written-response questions, sample student responses, and scoring rationales as they relate to the general scoring guide. These examples are intended to inform teachers and students of how the scoring guide is applied to specific questions and to encourage the use of the general scoring guide in class assignments. Teachers and students should note that directing words are bolded in written-response questions on diploma examinations. A list of these directing words and their definitions can be found on page 23. When a graphical solution is used, students should include the function or functions graphed, the window settings used, a sketch of the resulting calculator display, and a clear explanation of how the graphical display was used to solve the problem.

Sample 1

Use the following information to answer the next question

The owner of a hot-air balloon and blimp company obtained a loan for $50 000 to buy a new hot-air balloon. The following spreadsheet shows some entries in the repayment schedule.

	A	B	C	D	E
1		Repayment Schedule			
2					
3		Amount Borrowed	$50 000.00		
4		Monthly Payment	$1 556.00		
5		Period of the Loan (Months)	36	3 years	
6		Interest Rate (%/a)	7.5%		
7		Compounding Periods per Year	12		
8					
9	Month	Opening Balance	Interest Charged	Monthly Payment	Closing Balance
10	1	$50 000.00	I	$1 556.00	$48 756.50
11	2	$48 756.50	$304.73	$1 556.00	$47 505.23
12	3	$47 505.23	$296.91	$1 556.00	$46 246.14
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
43	34	$4 583.06	$28.64	$1 556.00	$3 055.70
44	35	$3 055.70	$19.10	$1 556.00	$1 518.80
45	36	$1 518.80	$9.49	$1 528.29	$0.00

Written Response—15%

I = 312

3. a. • Calculate the value for **I** in cell C10 in the spreadsheet above.

7.5% / 12 = 0.625% = 0.00625

$50000.00 × 0.00625 = $312.50

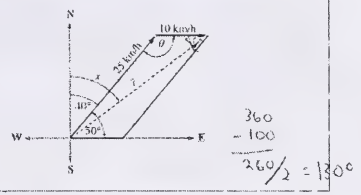
I = $312.50

• **Explain** why the final monthly payment is $1 528.29 instead of $1 556.00.

There is only $1528.29 left owing on the air balloon if the owner payed $1556.00 then he would have payed $27.71 to much.

Use the following additional information to answer the next part of the question.

A blimp is flying with an airspeed of 25 km/h on a bearing of 40°. The path of the blimp is being affected by a wind blowing from the west at 10 km/h, as shown in the diagram below.

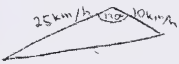


360 − 100 = 260

260 / 2 = 130°

b. The measure of angle θ in the diagram above is 130° .

c. • **Determine** the magnitude, *r*, of the resultant velocity of the blimp. Round your answer to the nearest tenth of a kilometre per hour.



$a^2 = b^2 + c^2 - 2bc \cdot \cos A$

$a^2 = 25^2 + 10^2 - 2(25)(10) \cdot \cos(130)$

$a^2 = 908.65$

$a = \sqrt{908.65}$

$a = 30.1$ km/h

• **Determine** the bearing, *x*, of the actual path of the blimp. Round your answer to the nearest degree.

$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

$\cos C = \frac{30.1^2 + 25^2 - 10^2}{2(30.1)(25)}$

$\cos C = 0.9508$

$\angle C = \cos^{-1}(0.9508)$

$\angle C = 0.3148°$

$= 0.3°$

$x = 40° + 0.3°$

$x = 40.3°$

The blimp has a bearing of 40.3°

Score – 4

Rationale

The student applied appropriate strategies, mathematical processes, and problem-solving techniques to find a complete solution to the problem; however, the solution contains an error that hinders understanding of the response. In part c, the student's calculator was in radian mode instead of degree mode; therefore, the strategies the student applied to solve this part of the problem are correct, but the solutions obtained from these strategies are incorrect. The solutions to parts a and b were correct and clearly communicated.

Sample 2

Use the following information to answer the next question.

The owner of a hot-air balloon and blimp company obtained a loan for $50 000 to buy a new hot-air balloon. The following spreadsheet shows some entries in the repayment schedule.

	A	B	C	D	E
1		**Repayment Schedule**			
2					
3		Amount Borrowed	$50 000.00		
4		Monthly Payment	$1 556.00		
5		Period of the Loan (Months)	36		
6		Interest Rate (%/a)	7.5%		
7		Compounding Periods per Year	12		
8					
9	**Month**	**Opening Balance**	**Interest Charged**	**Monthly Payment**	**Closing Balance**
10	1	$50 000.00	I	$1 556.00	$48 756.50
11	2	$48 756.50	$304.73	$1 556.00	$47 505.23
12	3	$47 505.23	$296.91	$1 556.00	$46 246.14
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
43	34	$4 583.06	$28.64	$1 556.00	$3 055.70
44	35	$3 055.70	$19.10	$1 556.00	$1 518.80
45	36	$1 518.80	$9.49	$1 528.29	$0.00

Written Response—15%

3. a. • Calculate the value for I in cell C10 in the spreadsheet above.

50 000 - 1556 = 48444 - 48756.5 = -312.5

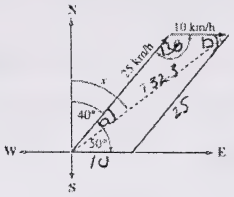
I = 312.5

• Explain why the final monthly payment is $1 528.29 instead of $1 556.00.

because that is all that is left to be paid. 1518.80 + 9.49 = 1528.29

Use the following additional information to answer the next part of the question.

A blimp is flying with an airspeed of 25 km/h on a bearing of 40°. The path of the blimp is being affected by a wind blowing from the west at 10 km/h, as shown in the diagram below.



b. The measure of angle θ in the diagram above is 130 °.

50 + 50 - 360 = 260/2 = 130

c. • **Determine** the magnitude, r, of the resultant velocity of the blimp. Round your answer to the nearest tenth of a kilometre per hour.

$a^2 = b^2 + c^2 - 2bc \cdot \cos A$

$a^2 = 25^2 + 10^2 - 2(25)(10) \cdot \cos 130$

$\sqrt{a^2} = \sqrt{1046.393805}$

$a = 32.34801083$ $r = 32.3$ km/h

• **Determine** the bearing, x, of the actual path of the blimp. Round your answer to the nearest degree. SOH CAH TOA

$\tan^{-1}\left(\frac{10}{25}\right)$

$\angle a = 21.8$

$\angle a = 22°$

$x = 40° + 22°$

$x = 62°$

Score – 3

Rationale

The student used appropriate strategies, mathematical processes, and problem-solving techniques to find partial solutions to the problem. The student correctly answered part a, but an oblique triangle was given in parts b and c, so the use of right-angled trigonometry was not an appropriate strategy to solve these parts of the problem. Therefore, the response reflects a basic understanding of the problem.

Sample 3

Use the following information to answer the next question.

Six students from a particular class are travelling by airplane to Europe. They are each allowed to take two suitcases, and no suitcase should have a mass over 32 kg. Any suitcase with a larger mass is classified as overweight, and an extra charge is applied.

At check-in, the mass of each suitcase is determined. The table below lists the mass of each suitcase.

Name	Mass	
	First Suitcase (kg)	Second Suitcase (kg)
Robin	29	24
Terri	27	41
Brianne	31	27
Chantey	34	23
Charlotte	26	30
Mireille	35	28
Total mass of all suitcases		353 kg

Written Response—10%

2. a. • Calculate, to the nearest tenth of a kilogram, the mean and standard deviation of the masses of all 12 suitcases.

Mean = 30.3 kg

Standard deviation = 3.3 kg

• The airline knows that suitcase masses model a normal distribution. Using your answers from the previous bullet, **determine** the percentage, to the nearest whole number, of all suitcases that the airline can estimate will be over 32 kg.

$z = \frac{x - \mu}{\sigma}$

$= \frac{32 - 30.3}{3.3}$

$z = 0.52$

normalcdf(0.52,5) = 0.3015

0.3015 × 100 = 30%

The airline can estimate that 30% of suitcases will be over 32kg

4

Use the following additional information to answer the next part of the question.

The students do not want to leave anything behind or pay extra charges for overweight suitcases, so they decide to repack some of the suitcases. They decide that those students with overweight suitcases will first move items from one of their suitcases to the other. If a student still has an overweight suitcase, she must then move some items into another student's suitcase.

b. Complete the following table to show how the students could rearrange their items in the suitcases so that there are no overweight suitcases.

Name	Mass		
	First Suitcase (kg)	Second Suitcase (kg)	
Robin	29	28	added 4kg from Terry to Robin's second suitcase
Terri	32	32	first suitcase 5kg from Terry's second suitcase to
Brianne	31	27	No change
Chantey	32	25	added 2kg from first suitcase to second suitcase
Charlotte	26	30	No change
Mireille	32	31	added 3kg from first case to second suitcase
Total mass of all suitcases		353kg	

c. **Explain** how repacking the suitcases may affect the mean and standard deviation of the masses of all 12 suitcases. **Justify** your answer.

The mean stays the same but the standard deviation went down to 2.2 because the weight is more evenly distributed and closer to the mean.

Score – 3

Rationale

The student's response reflects a basic understanding of the problem. Part a, bullet 2, was done correctly based on incorrect values from bullet 1; therefore, the student was given credit for this part of the problem. The student's response to part b was correct and clearly explained, but in part c, the student did not justify the change to the mean. This omission affected the clarity of the response for this part of the problem.

Sample 4

Use the following information to answer the first question.

A homeowner has a budget of $3 000 to renovate the bathtub area of a bathroom. The table below shows the cost of everything required in the renovation except for the cost of replacing the tiles surrounding the bathtub.

Item	Quantity	Unit Price	Total Price
Jet Tub	1	$2 200	$2 200
Faucets (set)	1	$ 150	$ 150
Plumbing Costs	N/A	N/A	$ 200
Tiles			
		Total Cost	$3 000

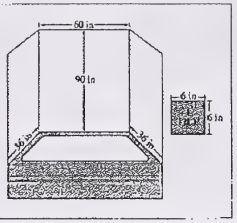
All prices include GST.

Written Response—10%

1. a. If the homeowner must stay within his budget, then the amount of money that he can spend on tiles is $ 450

Use the following additional information to answer the next part of the question.

The diagram at the right shows the measurements of the three walls that will have tiles. The tiles that the homeowner will use are 6 in. by 6 in.



b. Determine the maximum price per tile that the homeowner can spend in order to stay within the budget. Assume that no tiles break.

$A = 60 \times 90 = 5400$

$A = 36 \times 90 = 3240$

$A = 36 \times 90 = 3240$

$5400 + 3240 + 3240 = 11880$

$6 \times 6 = 36$

$\frac{11880}{36} = 330$

$\frac{450}{330} = 1.36$

maximum price per tile should be $1.36

Use the following additional information to answer the next part of the question.

The homeowner decides to spend extra money to paint the bathroom walls. He measures the walls and determines that there is 110 ft^2 to paint. There is currently oil-based paint on the walls, but he wants them painted with latex paint. He must choose one of the following two options.

Option A: Paint the walls with 1 coat of primer. Then, paint the walls with 1 coat of latex paint. The primer and the latex paint each cost $9.33 per 945 mL can. Each can will cover 90 ft^2.

Option B: Paint the walls with a different brand of latex paint that is specifically designed to go directly over oil-based paint. The homeowner will need to apply 2 coats of this paint. A 945 mL can of this paint costs $13.78 and will cover 87.5 ft^2 to 112.5 ft^2.

All prices include GST. Primer and paint are sold only in full cans.

c. Which option should the homeowner choose if he wishes to minimize costs? Justify your answer mathematically.

Option A - $9.33 + 9.33 = 18.66$

$90ft^2 + 90ft^2 = 180ft^2$

$18.66 - 13.78 = 4.88$

The homeowner should choose option B, because it is cheaper. It also covers 87.5 ft^2 to 112.5 ft^2.

option B - $13.78 + $13.78 = 27.56

Option A - $\underset{\downarrow}{\text{primer}}$ 9.33 + $\underset{\downarrow}{\text{latex}}$ 9.33 + $9.33 + 9.33 = 37.32$

$\downarrow$ $90ft^2$ $\quad$ $90ft^2$

not enough to cover $110ft^2$

Score – 3

Rationale

The student's response reflects a basic understanding of the problem rather than a good understanding as a result of an omission. The student correctly answered parts a and b, but in part c, neglected to address the cost associated with the range of area coverage possible for the option B paint. Option B is cheaper only if each can covers 112.5 ft^2. Since the student did not clearly state this, the response contains an omission that affects clarity, and the student earned 3 marks out of a possible 5.

Sample 5

Use the following information to answer the first question.

A homeowner has a budget of $3 000 to renovate the bathtub area of a bathroom. The table below shows the cost of everything required in the renovation except for the cost of replacing the tiles surrounding the bathtub.

Item	Quantity	Unit Price	Total Price
Jet Tub	1	$2 200	$2 200
Faucets (set)	1	$ 150	$ 150
Plumbing Costs	NA	NA	$ 200
Tiles			
		Total Cost	$3 000

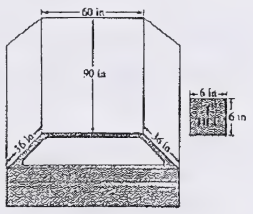
All prices include GST.

Written Response—10%

1. a. If the homeowner must stay within his budget, then the amount of money that he can spend on tiles is $ 450.

Use the following additional information to answer the next part of the question.

The diagram at the right shows the measurements of the three walls that will have tiles. The tiles that the homeowner will use are 6 in. by 6 in.



b. Determine the maximum price per tile that the homeowner can spend in order to stay within the budget. Assume that no tiles break.

$36 \times 10 = 3240$
$36 \times 40 = 3740$
$60 \times 90 = 5400$ } $11880\ in^2 = 330$ tiles

$\frac{330}{450} = .73$ cents per tile

Use the following additional information to answer the next part of the question.

The homeowner decides to spend extra money to paint the bathroom walls. He measures the walls and determines that there is 110 ft^2 to paint. There is currently oil-based paint on the walls, but he wants them painted with latex paint. He must choose one of the following two options.

Option A: Paint the walls with 1 coat of primer. Then, paint the walls with 1 coat of latex paint. The primer and the latex paint each cost $9.33 per 945 mL can. Each can will cover 90 ft^2.

Option B: Paint the walls with a different brand of latex paint that is specifically designed to go directly over oil-based paint. The homeowner will need to apply 2 coats of this paint. A 945 mL can of this paint costs $13.78 and will cover 87.5 ft^2 to 112.5 ft^2.

All prices include GST. Primer and paint are sold only in full cans.

c. Which option should the homeowner choose if he wishes to minimize costs? Justify your answer mathematically.

Option A: $9.33 primer + 90 ft²
$9.33 Latex + 90 ft²
$9.33 primer for the rest
$9.33 latex for the rest
$37.32

Option B:
13.78 1st coat
13.78 2nd coat
$27.56

$37.56 will be cutting it close for amount of paint that the Home owner has if the Home owner decides to buy another can of paint incase he doesn't have enough; it will be $41.34 the Homeowner should go with option A because the range on option B is to an impart and the maximum use for option B is just what he needs to cover the walls

Score – 4

Rationale

In the response, the student showed a good understanding of the problem and applied appropriate strategies. In part c, the student addressed the range of paint coverage in option B and clearly communicated why he or she would recommend option A. Since the student made a calculation error in part b, he or she earned 4 marks out of a possible 5.

Sample 6

Use the following information to answer the next question.

Regression models can be used to predict the increase that occurs in a particular population of birds that results from the hatching of eggs and the decrease in their population that results from death. The predictions for a particular bird population are shown below.

Increase in population at end of breeding season: 130%

Decrease in population as a result of death: 60%

Year	Initial Population	Increase (130%)	Population at End of Breeding Season	Decrease (60%)	Total Population at End of Year
0	N/A	N/A	N/A	N/A	200
1	200	260	460	-276	184
2	184	239	423	-253	170
3	170	221	391	-235	156

Written Response—10%

2. a. Complete the row for year 3 in the table above. Round each value to a whole number of birds.

b. • Perform an exponential regression on the data in the table shown below, and state your regression equation in the form $y = a \cdot b^x$. Round the value of a to the nearest whole number and the value of b to the nearest hundredth.

Year	Total Population at End of Year
0	200
1	184
2	170

a=100
b=0.92

Use the following additional information to answer the next part of the question.

For a different species of bird, the predicted total population at the end of each year can be modelled by the exponential regression equation

$$y = 200(1.05)^x$$

• Is the total population of these birds increasing or decreasing over time? Justify your answer mathematically.

$200(1.05)^1 = 210$
$200(1.05)^2 = 221$
$200(1.05)^{10} = 326.$

Use the following additional information to answer the next part of the question.

The mass of each adult bird in a different population was measured. The masses form a normal distribution with a mean of 1.24 kg and a standard deviation of 0.08 kg.

c. • Determine the probability, to the nearest hundredth, that a bird in a sample of 200 birds from this population has a mass less than 1.20 kg.

normalcdf(-10^99, 1.20, 1.24, 0.08) = 0.31

• Determine how many birds out of the 200 birds in this sample are expected to have a mass less than 1.20 kg.

200 × 0.31 = 62 birds

Score – 4

Rationale

In the response, the student showed a good understanding of the problem and used appropriate strategies, mathematical processes, and problem-solving techniques to find a complete solution to the problem. Although the student did not state a regression equation in the first bullet in part b, this is not considered an error that hinders understanding because the student stated the appropriate values to be used in the form of the equation that was given in the question. In bullet 2 of part b, the student calculated the population of birds over certain time intervals; however, since these time intervals were not consecutive, the student did not clearly justify or state whether the population of birds is increasing or decreasing over time.

Sample 7

Use the following information to answer the next question.

Regression models can be used to predict the increase that occurs in a particular population of birds that results from the hatching of eggs and the decrease in their population that results from death. The predictions for a particular bird population are shown below.

Increase in population at end of breeding season: 130%

Decrease in population as a result of death: 60%

Year	Initial Population	Increase (130%)	Population at End of Breeding Season	Decrease (60%)	Total Population at End of Year
0	N/A	N/A	N/A	N/A	200
1	200	260	460	–276	184
2	184	239	423	–253	170
3	170	221	391	-234	157

Written Response—10%

2. a. Complete the row for year 3 in the table above. Round each value to a whole number of birds.

b. • Perform an exponential regression on the data in the table shown below, and state your regression equation in the form $y = a \cdot b^x$. Round the value of a to the nearest whole number and the value of b to the nearest hundredth.

Year	Total Population at End of Year
0	200
1	184
2	170

EXPRESS
0 200
1 184
2 170
3 157

$y = 199.76 \cdot 0.92^{x}$ (0, 1, 2, 3 etc)

Use the following additional information to answer the next part of the question.

For a different species of bird, the predicted total population at the end of each year can be modelled by the exponential regression equation

$$y = 200(1.05)^x$$

• Is the total population of these birds increasing or decreasing over time? Justify your answer mathematically.

x	
1	210
2	220.5
3	231.5

$200(1.05)^x$ THE TOTAL POPULATION OF THESE BIRDS ARE INCREASING OVER TIME.

Use the following additional information to answer the next part of the question.

The mass of each adult bird in a different population was measured. The masses form a normal distribution with a mean of 1.24 kg and a standard deviation of 0.08 kg.

c. • Determine the probability, to the nearest hundredth, that a bird in a sample of 200 birds from this population has a mass less than 1.20 kg.

• Determine how many birds out of the 200 birds in this sample are expected to have a mass less than 1.20 kg.

Score – 3

Rationale

The student applied mathematical knowledge to find a partial solution to the problem by correctly completing parts a and b. In the first bullet of part b, the student did not correctly round the values for a and b in the regression equation; however, this was a minor error that did not hinder the understanding of the response, so the student was not penalized.

Sample 8

Use the following information to answer the next question.

The chart below illustrates the number of movies on VHS tape and the number on DVD that each of three stores ordered from the same wholesale company in a particular month.

Store Name	Number of VHS tapes	Number of DVDs
Future Depot	240	135
World of Movies	200	100
Kat's Movies	310	200

The wholesale price and selling price of VHS tapes and of DVDs are shown in the chart below. The selling price of the VHS tapes and the selling price of the DVDs were the same in each store.

	Wholesale Price	Selling Price
VHS tapes	$5.00	$15.00
DVDs	$8.00	$25.00

Written Response—15%

3. a. Calculate the total wholesale cost of all the VHS tapes purchased by Future Depot.

240 x 5 = $1200.00

b. Each store sold all of its VHS tapes and all of its DVDs. Using matrix multiplication, determine the total wholesale cost and the total revenue for each store. Label the rows and columns of your resulting matrix.

$$\begin{bmatrix} 240 & 135 \\ 200 & 100 \\ 310 & 200 \end{bmatrix} \times \begin{bmatrix} 5.00 & 15.00 \\ 8.00 & 25.00 \end{bmatrix} = \begin{matrix} FD \\ WM \\ KM \end{matrix} \begin{bmatrix} 2280 & 6975 \\ 1800 & 5500 \\ 3150 & 9650 \end{bmatrix}$$

[A] [B] WC SP

Future Depot's WC was 2280, Rev was 6975 - 2280 = $4695
World of movies W.C. was 1800, Rev was 5500 - 1800 = $3700
Kat's movies W.C. was 3150, Rev was 9650 - 3150 = $6500

c. Describe how you can use the product matrix from part b to determine Kat's Movies profit. Your answer should make reference to particular entries in the matrix.

No because the price that he had to pay to get them went up by 5% aswell.

Use the following additional information to answer the next part of the question

The following month, the wholesale company increased the wholesale price of VHS tapes and the wholesale price of DVDs by 5%. All three stores also increased their selling prices by 5%. Each store ordered the same number of VHS tapes and DVDs, and again each store sold all of them.

d. • Using matrix operations, determine the new wholesale price and the new selling price of each type of movie. Label the rows and columns of your resulting matrix.

A B WS S.P.

$$\begin{bmatrix} 5 & 15 \\ 8 & 25 \end{bmatrix} \times \begin{bmatrix} .05 \\ .05 \end{bmatrix} = \begin{bmatrix} 5.25 & 15.75 \\ 8.40 & 26.25 \end{bmatrix}$$

• As a result of the 5% increases, will Kat's Movies profit also increase by 5%? Justify your answer mathematically.

VHS DVD

310 310

310 x 5.25 = 1627.5 310 x 8.40 = 2604

310 x 15.75 = 4882.5 310 x 26.25 = 8137.5

Score – 3

Rationale

The student's response reflects a basic understanding of the problem with a partial solution. The student correctly answered part a, used an appropriate matrix operation to answer part b, and set up an appropriate matrix operation in the first bullet in part d that could have led to a correct solution. However, the student did not clearly communicate whether he or she understands revenue and profit, as is evident in part b.

Sample 9

Use the following information to answer the next question.

The chart below illustrates the number of movies on VHS tape and the number on DVD that each of three stores ordered from the same wholesale company in a particular month.

Store Name	Number of VHS tapes	Number of DVDs
Future Depot	240	135
World of Movies	200	100
Kat's Movies	310	200

The wholesale price and selling price of VHS tapes and of DVDs are shown in the chart below. The selling price of the VHS tapes and the selling price of the DVDs were the same in each store.

	Wholesale Price	Selling Price
VHS tapes	$5.00	$15.00
DVDs	$8.00	$25.00

Written Response—15%

3. a. Calculate the total wholesale cost of all the VHS tapes purchased by Future Depot.

VHS DVD
Future Depot [240, 135] VHS 240·5 = $1200
DVD 135·8 = $1080

The wholesale cost for VHS is $1200, for DVD its $1080.

b. Each store sold all of its VHS tapes and all of its DVDs. Using matrix multiplication, determine the total wholesale cost and the total revenue for each store. Label the rows and columns of your resulting matrix.

resulting matrix
Total wholesale cost | Total revenue
Future Depot $2280, $6975
World of Movies $1800, $5500
Kat's Movies $3190, $9650

matrix A (VHS, DVD) · matrix B (wholesale price, selling price)
VHS: 5.00, 15.00
DVD: 8.00, 25.00

Using Matrix A · Matrix B the resulting matrix shows the Total wholesale and total revenue for the 3 movie stores.

c. Describe how you can use the product matrix from part b to determine Kat's Movies profit. Your answer should make reference to particular entries in the matrix.

To determine the profit of Kats Movies you take the value $9650 (row 3, column 2) and subtract $3150 (row 3, column 1) from it. The result profit from the sales in Kats Movies would be $6500.

Use the following additional information to answer the next part of the question.

The following month, the wholesale company increased the wholesale price of VHS tapes and the wholesale price of DVDs by 5%. All three stores also increased their selling prices by 5%. Each store ordered the same number of VHS tapes and DVDs, and again each store sold all of them.

d. • Using matrix operations, determine the new wholesale price and the new selling price of each type of movie. Label the rows and columns of your resulting matrix.

matrix A · 1.05 =
Total wholesale revenue | Total revenue
Future Depot $2394, $7323
World of Movies $1890, $5775
Kat's Movies $3307.50, $10132.50

• As a result of the 5% increases, will Kat's Movies profit also increase by 5%? Justify your answer mathematically.

Yes, the profit will also increase by 5% because both the former wholesale cost and revenue have increased by 5%, the Total revenue is a different number making the 5% increase on it fluctuate differently as well.

eg. 9650 − 3150 = 6500 → 10,132.50 − 3307.50 = 6825 → 6500 · 1.05 = 6825

Score – 4

Rationale

The student applied appropriate mathematical knowledge to find a complete solution, and the response reflects a good understanding of the problem. The student used matrix operations and labelled the rows and columns of the resulting matrix. However, the student incorrectly answered part d, bullet 1, which hindered understanding of the response.

Mathematics and Science Directing Words

Discuss	The word "discuss" **will not** be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity.
	The following words are specific in meaning.
Algebraically	Using mathematical procedures that involve letters or symbols to represent numbers
Analyze	To make a mathematical, chemical, or methodical examination of parts to determine the nature, proportion, function, interrelationship, etc., of the whole
Compare	Examine the character or qualities of two things by providing characteristics of both that point out their mutual *similarities* and *differences*
Conclude	State a logical end based on reasoning and/or evidence
Contrast/Distinguish	Point out the *differences* between two things that have similar or comparable natures
Criticize	Point out the *merits* and *demerits* of an item or issue
Define	Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits
Describe	Give a written account or represent the characteristics of something by a figure, model, or picture
Design/Plan	Construct a plan, i.e., a detailed sequence of actions, for a specific purpose
Determine	Find a solution, to a specified degree of accuracy, to a problem by showing appropriate formulas, procedures, and calculations
Enumerate	Specify one by one or list in concise form and according to some order
Evaluate	Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages
Explain	Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail
Graphically	Using a drawing that is produced electronically or by hand, and that shows a relation between certain sets of numbers

How	Show in what manner or way, with what meaning
Hypothesize	Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically
Identify	Recognize and select as having the characteristics of something
Illustrate	Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram
Infer	Form a generalization from sample data; arrive at a conclusion by reasoning from evidence
Interpret	Tell the meaning of something; present information in a new form that adds meaning to the original data
Justify/Show How	Show reasons for or give facts that support a position
Model	Find a model (in mathematics, a model of a situation is a pattern that is supposed to represent or set a standard for a real situation) that does a good job of representing a situation
Outline	Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps
Predict	Tell in advance on the basis of empirical evidence and/or logic
Prove	Establish the truth or validity of a statement for the general case by giving factual evidence or logical argument
Relate	Show logical or causal connection between things
Sketch	Provide a drawing that represents the key features of an object or graph
Solve	Give a solution for a problem; i.e., explanation in words and/or numbers
Summarize	Give a brief account of the main points
Trace	Give a step-by-step description of the development
Verify	Establish, by substitution for a particular case or by geometric comparison, the truth of a statement
Why	Show the cause, reason, or purpose

Applied Mathematics 30 Formula Sheet

Cost and Design

Perimeter

Circle $C = 2\pi r$

Area

Circle $A = \pi r^2$

Triangle $A = \dfrac{b \times h}{2}$

Parallelogram $A = b \times h$

Trapezoid $A = h\left(\dfrac{b_1 + b_2}{2}\right)$

Surface Area

Sphere $SA = 4\pi r^2$

Cylinder $SA = 2\pi r^2 + 2\pi rh$

Cone $SA = \pi r^2 + \pi rs$

Volume

Sphere $V = \dfrac{4}{3}\pi r^3$

Cylinder $V = \pi r^2 h$

Prism $V = B \cdot h$, where B is the area of the base

Cone $V = \dfrac{1}{3}\pi r^2 h$

Pyramid $V = \dfrac{B \cdot h}{3}$, where B is the area of the base

Graphing Calculator Window Format

x: $[x_{min}, x_{max}, x_{scl}]$

y: $[y_{min}, y_{max}, y_{scl}]$

Trigonometry and Vectors

In degree mode:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cdot \cos A$$

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

Statistics and Probability

$$\mu = np$$

$$\sigma = \sqrt{np(1-p)}$$

$$z = \frac{x - \mu}{\sigma}$$

95% C.I.: $\mu \pm 1.96\sigma$

$$P(A \text{ or } B) = P(A) + P(B)$$

$$P(A \text{ and } B) = P(A) \cdot P(B)$$

$$P(A \text{ and } B) = P(A) \cdot P(B \mid A)$$

Regression Models

In radian mode:

$$y = a \cdot \sin(bx + c) + d$$

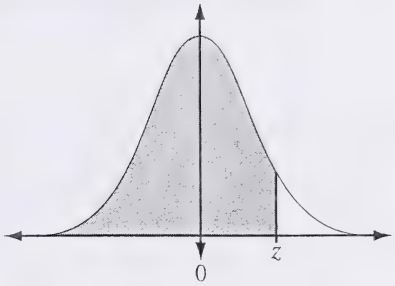
$$\text{period} = \frac{2\pi}{b}$$

$$y = ax^2 + bx + c$$

$$y = ax + b$$

$$y = a \cdot b^x$$

$$z = \frac{x - \mu}{\sigma}$$



Areas Under the Standard Normal Curve

z	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00
–3.4	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
–3.3	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
–3.2	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007
–3.1	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
–3.0	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013
–2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
–2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
–2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
–2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
–2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
–2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
–2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
–2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
–2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
–2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
–1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
–1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
–1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
–1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
–1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
–1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
–1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
–1.2	0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151
–1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
–1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
–0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
–0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
–0.7	0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420
–0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
–0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
–0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
–0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
–0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
–0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
–0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

Areas Under the Standard Normal Curve

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Diploma Examinations Program Calculator Policy

POLICY

Pure Mathematics 30 and Applied Mathematics 30 require the use of an **approved graphing calculator** for diploma examinations. All science diploma examinations require the use of a scientific calculator or an approved graphing calculator. School authorities are required to ensure that students taking Pure Mathematics 30 or Applied Mathematics 30 have access to an approved graphing calculator for diploma examinations.

DEFINITION

The calculator must be a hand-held device designed primarily for mathematical computations, including logarithmic and trigonometric functions, as well as for graphing functions. Included in this definition are those scientific calculators having graphing and programmable features.

RATIONALE

Any scientific calculator will be adequate for any science diploma examination. Many students will use an approved graphing calculator, which is also sufficient for science diploma examinations.

The student learning outcomes of the *Information and Communication Technology (K-12) Program of Studies (2000–2003)* are being infused into all subject areas. The *Mathematics Applied and Pure Programs of Study* state:

> *Improvements in technology and its increased availability in schools have changed the focus of mathematics education. The time saved by using calculators or computers to perform complex calculations can be used to help students better understand mathematical concepts. Students can then understand the relationships among concepts and use these relationships to solve problems.*
>
> *Calculators and computers can be used as tools to:*
>
> - *explore and demonstrate mathematical relationships and patterns*
> - *organize and display data*
> - *assist with solving problems*
> - *decrease the time spent on tedious computations*
> - *simulate situations*

To ensure compatibility with the provincial *Programs of Study* and equity and fairness to all students, Alberta Education expects students to use calculators, as defined, when writing diploma examinations in mathematics and the sciences. Students must not use non-approved graphing calculators for diploma examinations because to do so may confer an undue advantage or undue disadvantage on the student. For example, the use of an older, previously but not currently approved graphing calculator for a mathematics diploma examination will disadvantage the student through the calculator's inability to perform functions required by the *Mathematics Applied and Pure Programs of Study.*

Professional mathematics organizations such as the National Council of Teachers of Mathematics (NCTM) have strongly endorsed the use of graphing calculators in mathematical instruction. They also emphasize that if calculator and computer technologies are now accepted as part of the environment in which students learn and do mathematics, such tools should also be available to students in most assessment situations.

The *Programs of Study* for the Pure Mathematics 30 and Applied Mathematics 30 mandate the use of graphing calculators. Although many questions on the mathematics diploma examinations will not require the use of a graphing calculator, there will be some questions for which the use of an approved graphing calculator will be required.

Calculators that do not meet the minimum properties, such as the TI-81, the TI-82, the TI-85, and scientific calculators, will disadvantage students who may wish to use them on a Pure Mathematics 30 or Applied Mathematics 30 diploma examination and are therefore not approved for diploma examination use.

Note: This policy applies to Alberta Education diploma examinations and field tests only. School calculator policies may differ depending on grade level or topic studied.

EXPECTATIONS

1. At the beginning of **any** mathematics or science diploma examination course, teachers **must** advise students of the types of calculators approved by Alberta Education for use when writing diploma examinations in these courses.

2. Students must clear **all** programmable calculators, both graphing and scientific, that are brought into diploma examinations of all information that is stored in the programmable or parametric memory. Programmable calculators should be cleared **both** before and after the administration of a diploma examination.

3. Students must not bring external devices (peripherals) to support calculators into any examination. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, CD-ROMs, libraries, or any annotations that outline operational procedures.

4. In preparation for calculator failure, students may bring extra batteries and/or approved calculators into the examination room.

5. During examinations, supervising teachers must ensure that:
   - calculators operate in silent mode
   - students do not share calculators or information contained within them
   - calculator cases are not available to students
   - programmable calculator memories, including parametric memories, have been cleared
   - only graphing calculators on the current list approved by Alberta Education are used

CALCULATOR CRITERIA

The following criteria will be used to select acceptable calculators.

Minimum calculator properties required

1. Function graphing capabilities with display
   —includes displaying more than one function on the screen at a time, tracing a function
2. Standard scientific calculator operations
   —e.g., sine, cosine, tangent, inverse functions, logarithms, power (x^n)
3. Statistical functions in 1 and 2 variables
   —mean, median, mode, standard deviation, bivariate data
4. Regression models
   —linear, quadratic, exponential, sinusoidal
5. List capabilities
6. Matrix capabilities
   —scalar multiplication, addition, and subtraction

Unacceptable calculator properties during examinations

1. Built-in notes (definitions or explanations in alpha notation), e.g., libraries
2. Upgrades/downloads that include built-in notes or formulas
3. Remote communication capability

The following list of approved calculators is provided to assist students and teachers in the selection of graphing calculators that conform to the requirements stated in the definition and to the stated criteria. The list will be updated annually.

Note: All the calculators listed below meet the "required properties." They do not have any "unacceptable properties" and so can be used on the mathematics and science diploma examinations. However, students and teachers should recognize that the different models of calculators listed have a range of capabilities, and the choice of which model to use or purchase will require personal or teacher analysis of the machines' capabilities and one's individual or school circumstances.

The List of Approved Graphing Calculators for 2008–2009

Brands	*Casio*	*Sharp*	*Texas Instruments*
Models	fx 9750 G Plus	EL-9600C EL-9900	TI-83 Plus TI-83 Plus Silver TI-84 Plus TI-84 Plus Silver TI-86 TI-89 TI-89 Titanium TI-92 Plus TI Voyage 200 TI-Nspire with TI-84 keypad ONLY (see *Notes* below)

The following calculators meet the graphing calculator criteria and are approved, but are no longer commercially manufactured.

Brands	*Sharp*	*Texas Instruments*
Models	EL-9600	TI-83 TI-92

Notes:

- Instructions for clearing calculator memories are outlined on the next few pages of this document.
- Resetting calculators may result in altering the calculator mode settings. Please remind students to check the mode settings before proceeding with the diploma examination.
- Programs downloaded from the web are not allowed on the calculators used during diploma examinations. These programs must be erased before the student is allowed to write the examination.
- The memory values given on the next pages refer to memory expected to be available as a factory setting. The values available in student calculators should match these values when the calculator has been reset. If the memory values in the student calculators do not match these values, then the calculators should be turned off and reset a second time. If this fails to change the values, then the calculator should not be used on the examination.
- To aid with the preparing of *Texas Instruments* calculators for diploma examinations, the APPS program *TestGuard* $_{TM}$ *2.0* or the *Press-to-Test* feature in operating system 2.40 or higher may be used. For more information, refer to the *Texas Instruments* web site.
- The TI-Nspire is **not approved** for use with the TI-Nspire keypad.

For Further Information

If you have any questions or comments about this policy, please contact the Director, Mathematics/Science Diploma Examination Unit, Learner Assessment (see *Contacts*).

Keystrokes Required For Clearing Approved Calculators

Texas Instruments	Memory remaining
TI-83 2^{nd} + (MEM) **5** (Reset) **1** (All memory) **2** (Reset) **Note: If, on clearing, the screen is blank, the contrast needs to be reset. To do this, use both 2^{nd} and ⇑ repeatedly.**	2^{nd} + **1** RAM 27118
TI-83 Plus **or** TI-83 Plus Silver Edition or TI-84 Plus **or** TI-84 Plus Silver Edition 2^{nd} + (MEM) **7** (Reset) ➤ ➤ (All)* **Enter** **2** (Reset) **The application "Finance" is the only one that remains after following the clearing instructions.** **Note: If, on clearing, the screen is blank, the contrast needs to be reset. To do this, use both 2^{nd} and ⇑ repeatedly.** *** The third step is very important; if not followed, the memory may not be cleared properly.**	TI-83 Plus **or** TI-84 2^{nd} + **2** RAM 24317 ARC 163840 TI-84 Plus 2^{nd} + **2** RAM 24317 ARC 491520 TI-83 Plus Silver or TI-84 Plus Silver Editions 2^{nd} + **2** RAM 24317 ARC 1540K
TI-86 2^{nd} **3** (MEM menu) **F3** (Reset) **F1** (All) **F4** (Yes) **Note: If, on clearing, the screen is blank, the contrast needs to be reset. To do this, use both 2^{nd} and ⇑ repeatedly.**	2^{nd} **3** **F1** MEM FREE 98226
TI-89 2^{nd} **6** (MEM) **F1** (All) **1** (Reset) Enter	2^{nd} **6** RAM 199154 ARC 393204
TI-92 **or** TI-92 Plus 2^{nd} **6** (MEM) **F1** (Reset) **1** (All) **Enter** **Note: If, on clearing, the screen is blank, the contrast needs to be reset. To do this, use ◊ (green) and + or – repeatedly.**	2^{nd} **6** System 61064 Memory Free 70008

Texas Instruments-continued

	Memory remaining
TI Voyage 200, TI-89 Titanium 2^{nd} **6** (MEM) **F1** (RESET) **3** (All Memory) **Enter** (YES) **Note: If, on clearing, the screen is blank, the contrast needs to be reset. To do this, use ◊ (green) and + or - repeatedly.**	(Titanium) 2^{nd} **6** System 70516 (68098) RAM free 191628 (194046) Flash ROM free 2818018 (2686896)

Casio

	Memory remaining
fx-9750G Plus Go to **Menu** Cursor to **MEM** **EXE** Reset **EXE** **F1** yes - reset	Go to **Menu** Cursor to **MEM** **EXE** **Memory Usage (28628 Bytes Free)**

Sharp

	Memory remaining
Sharp EL-9600, and 9600 C 2^{nd} **XθTN** (Option) **Log** (Reset) **2** (All Memory) **CL** (Clear all data) **Note: There is also a reset switch on the back. (Use round tip of pen, press, then CL)**	2^{nd} **XθTN** **18562** ⇓
Sharp EL-9900 2^{nd} + − × ÷ (Option) ln (Reset) **2** (All Memory) **CL** (Clear all data)	2^{nd} + − × ÷ (Option) **Cos** (MEMCHK) (47447)

If you find that there are problems with any of the clearing techniques, please contact the Director, Mathematics/Science Diploma Examination Unit, Learner Assessment (see *Contacts*).